

Approved by:

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## 1 SCOPE

The purpose of this document is to detail the use of the Ultratech S200 G2 Savannah ALD. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

## 2 REFERENCE DOCUMENTS

- Ultratech S200 G2 Savannah

## 3 DEFINITIONS

n/a

## 4 TOOLS AND MATERIALS

### 4.1 General Description

- 4.1.1 The Ultratech S200 G2 Savannah ALD system is a single chamber atomic layer deposition system. It has six precursor channels number 0-5 and has Deionized H<sub>2</sub>O, HfO<sub>2</sub>, TMA, TDMAT, TiO<sub>2</sub>, ZrO<sub>2</sub> or DEZ. Precursors can change with the needs of users but must be scheduled with the SMFL to make any changes.
- 4.1.2 The system uses 99.999% pure nitrogen from the bottle source mounted to the right of the tool regulated to 20psi, and CDA from the overhead plumbed compressed air system with a regulator set to 30psi.
- 4.1.3 The system also includes a laptop computer that is always on which keeps the heaters running to prevent condensing in the precursor lines and valves, and a rough pump, Alcatel 2021 prepared for PTFE pump oil only that is always on.

## 5 SAFETY PRECAUTIONS

- 5.1 **Warning: Heated surfaces. Lid and chamber are heated. Keep safety cage installed when not loading or unloading a substrate.**
- 5.2 **Warning: Only the tool technician is allowed to change precursor cylinders. Pyrophoric gasses could cause a fire or explosion if done improperly.**
- 5.3 **Caution: This tool must remain on with vacuum pump running and the chamber under vacuum when not in use to prevent precursors from collecting on valves and tubing.**
- 5.3 **Caution: Never turn off the computer. The idle recipe state runs through the laptop and controls vacuum and heaters constantly.**
- 5.4 **Caution: No user needs to open the cabinet. If gases don't flow or tool does not run contact the technician for the tool. There are no user serviceable items in the cabinet. The cabinet should remain locked. SMFL personnel have the key.**
- 5.5 **Note: You must contact the process engineer or equipment tech before running zinc processes. This has to be treated differently when run to prevent contamination to other processes. After completing a DEZ process, a coating of  $\text{HfO}_2$  must be applied to coat the chamber after running Diethyl Zinc. Operators must plan this into their run time**
- 5.6 **Note: Always use metal tweezers to load and unload wafers or sample pieces.**
- 5.7 To run recipes with heaters over  $300^\circ\text{C}$  contact the process engineer. Inner and outer heater temperatures will have special settings (pg 53 of user manual)

## 6 Initial State Check

- 6.1 Idle should be displayed in the upper left hand corner of the screen.

- 6.2 The chamber should be under vacuum and the heaters should show red when active.
- 6.3 Heaters for the precursors if installed should be set to 0°C when not in use.
- 6.4 The trap should show 150°C.
- 6.5 The heaters for the inner and outer rings are controlled by recipe set points. At idle they should read valve manifold 150°C, the exhaust line and trap 150°C. Heaters must be at set point before running a recipe.
- 6.6 The scrolling screen should show the reactor at approximately 70-170mTorr (ie: 0.07-0.17Torr) displayed in the lower left corner. If the pressure goes over 0.75Torr with 20 sccm of nitrogen flowing contact the equipment engineer.
- 6.7 In the center of the display Nitrogen should show flow of 10 sccm at idle.

## 7 Operating the System

- 7.0 **CARD SWIPE in on Surface Analysis card swipe 17-2810.**
- 7.1 Precursor heaters should be set to 75°C and allowed 20-30 minutes to stabilize for the precursors used in your run. Heaters are installed on ports 2, 3 and 4 for HfO<sub>2</sub>, TiO<sub>2</sub> and ZrO<sub>2</sub>.
- 7.2 Set the N<sub>2</sub> flow to 20 sccm by clicking in the center of the screen on MFC-0, the N<sub>2</sub> flow number and change it from 10 to 20 sccm.

**Note: If the computer is ever found off contact the technician for the tool immediately. DO NOT RUN THE TOOL. It is not as simple as just turning it back on.**

- 7.3 Loading a Substrate: On the left side of the computer screen select Vent. Note in the black bar should read “Waiting for reactor pressure to rise above 600 Torr.”
- 7.4 Remove the cage and lift the lid to place your sample in the chamber.

**Warning: These parts are hot! Caution: If the chamber is below 100°C the o-ring could be tacky and might pull out of place or tear. If this happens call the technician to put it back in. Everything is hot!**

- 7.5 Place your sample in the chamber. Load a monitor sample of bare silicon wafer along with your substrate. Ensure the o-ring is in place and close the lid and put the cage back in place over the chamber. If using a sample with Methanol, flow N<sub>2</sub> for 2 hours before starting the recipe. Use the glass wafer with the lip for all methanol coated pieces. Carrier wafers are located to the left of the screen.
- 7.6 Select PUMP REACTOR on the left of the screen. Wait until the reactor pressure reads approximately 0.08 Torr.
- 7.7 Load an existing process recipe: Right click in the recipe area of the screen and choose load recipe at the top. A new screen will appear.
- 7.8 Select the PROCESS folder and select the recipe you wish to run.
- 7.9 Click open at the bottom of the new screen. The new screen will disappear and your recipe is loaded.

Note: Users will only be allowed to change the number of cycles based on their target thickness from the Dep Rate charts. We have the Savannah G2 for the Dep Rate Charts. See enclosure in back.

**Caution: Do not alter the wait times in the recipe. Times are set to protect the equipment. If temperatures are changed, the wait times (purge times) are changed per the chart (contact Process Engineers before changing temperatures).**

- 7.10 To change the number of cycles in the recipe, click on Values in the GO TO step. Add the appropriate number of cycles based on the Dep Rate charts enclosed to reach your target deposition. NOTE: TiO<sub>2</sub> growth rate is about half of the rate of the other precursors and is not linear over 350Å.
- 7.11 In the black message bar at the top of the screen you should read “Recipe Validated”. This ensures the recipe will run properly.
- 7.12 Press the START RECIPE button in the upper left of the screen. The black info bar will display information for each step as it proceeds with the recipe.

This bar will display the time for each step and the time elapsed for each step. The time for the total process is displayed in the center left screen as the estimated time remaining. The time may run over if the stabilization of the heaters takes longer. The Status Bar displays “Recipe Running” in the upper center of the screen along with the recipe name.

Note: During the run you should hear precursor pulses from the pneumatic valves opening and closing the source bottles. On graphical pressure display you should see the pressure spikes as the precursors are cycled on and off. A small green light will flash above the gas manifold display showing the valve open signal for the precursors used. Under the estimated time remaining in the center of the display, it shows the number of cycles completed. If the spikes drop off during the run for the DI water or precursor, stop the run and contact Pat Meller or Bruce Tolleson immediately.

## **8 Editing a Recipe**

Contact the process engineers, Pat Meller or Sean Obrien, for help in editing or creating a new recipe other than changing the cycle counts for existing recipes. All previously characterized recipes are listed in the PROCESS folder.

## **9 Ending a Run**

- 9.1 When the info bar displays RECIPE COMPLETE, click on VENT REACTOR. The graphical pressure display will show a rise towards atmospheric pressure, over 600 mTorr. Open as soon as the pressure levels off. If it won't open select vent again.
- 9.2 Once atmospheric pressure is reached, remove the cage and lift the lid all the way back to its open resting spot and with tweezers, remove your substrate and the monitor piece.
- 9.3 Close the reactor lid and place the safety cage back over it.

9.4 Select PUMP Reactor. In the upper left of the display it should now read IDLE and the N<sub>2</sub> flow should return to 10 sccm. Reactor pressure should return to 0.07-0.08mT as the reactor returns to normal idle temperatures. The black status bar should show PUMP SEQUENCE COMPLETE.

9.5 Enter 0°C for precursor heaters unless running immediately after.

9.6 Enter the run in the user log book to allow for the timely reorder of precursors.

**Caution: DO NOT TURN OFF THE COMPUTER OR VACUUM PUMP.**

9.7 Set inner and outer rings to 100°C.

9.8 Card swipe out in Surface Analysis 17-2810.

## 10 ATTACHMENTS

10.1 See Deposition Charts enclosed to determine number of cycles required.

### REVISION RECORD

Summary of Changes	Originator	Rev/Date
Original Issue	Bruce Tolleson	A: 09/19/2016
Rev B for changing precursors, removed card swipe for now, changed precursor heaters when idle to 0°C	Bruce Tolleson	B: 11/29/2016
Rev C added card swipe, TiO <sub>2</sub> dep rate, temperature and stabilization notes.	Bruce Tolleson	C: 05/10/2017
Rev D Changed the gas manifold from 4 precursors to 6 precursors.	Bruce Tolleson	D:03/12/2020